NONPOINT SOURCE SUCCESS STORY

Arizona

Fish Return to Boulder Creek After Legacy Mine Remediation

Waterbody Improved

Runoff and discharge from an inactive mine contributed metal pollution to Boulder Creek, an intermittent stream in the headwaters of the Colorado River watershed. In 2000, the Arizona Department of Environmental Quality (ADEQ) added a reach of Boulder Creek to Arizona's Clean Water Act 303(d) list as impaired for arsenic, copper, and zinc. State and federal remediation efforts conducted between 2016 and 2019 addressed tailings piles and a direct discharge from the mine. Metal levels and dropped and water quality in Boulder Creek has improved. The once-turbid water is now clear, fish are returning, and vegetation is becoming re-established.

Problem

Boulder Creek is an intermittent stream that flows approximately 37 linear miles from its headwaters near Camp Wood Mountain towards the confluence with Burro Creek in Western Yavapai County in central Arizona. The Boulder Creek watershed (10-digit hydrologic unit code 15030202-03) is part of the larger Bill Williams watershed draining into the Colorado River. Like most streams in Arizona, Boulder Creek's flow responds dramatically to seasonal weather conditions (Figure 1). Most of the land in the site area is a mix of private, Bureau of Land Management (BLM) and state trust land. Ranching, mining and open range are predominant land uses. Boulder Creek flows into Burro Creek, a popular recreational water.

Historic metal mining from the inactive Hillside Mine was identified as a source of pollution to Boulder Creek (Figure 2). Open from the late 1800s through 1951, HIllside Mine primarily produced silver and gold, with subordinate lead and zinc. An adit (i.e., a horizontal mineshaft usually used for dewatering) was continuously discharging contaminated water at a rate of five gallons per minute. Stormwater interacted with the tailings piles to release additional metals to the creek. Sulfide-bearing minerals in the tailings were weathered and oxidized, creating high concentrations of metals and acidic water leaching into Boulder Creek, which was discolored before remediation (Figure 3).

ADEQ completed a total maximum daily load (TMDL) analysis in 2002 and a TMDL implementation plan in 2004. The analyses identified three tailings piles and the discharging adit as main sources of arsenic, copper and zinc.

Figure 1. Boulder Creek's flow regimes are contrasted in these two pictures: high flows in February 2001 (left) and no flows in November 2001 (right).

Figure 2. The Hillside Mine location as it appeared in January 1940 (left) and January 2001 (right).

Figure 3. A discolored Boulder Creek flows near an eroding tailings pile (before remediation).

Figure 4. Before remediation, the adit discharged about 2.6 million gallons of contaminated water annually.

Figure 5. The remediated middle tailings pile area at Hillside Mine is adjacent to Boulder Creek.

Story Highlights

Since the TMDL analysis, ADEQ engaged with the U.S. Environmental Protection Agency (EPA) and the owners of the tailings piles to develop remediation methods. BLM completed the remediation of the upper tailings pile in 2015. The lower tailings pile was remediated in 2017 as a coordinated effort between the Arizona State Land Department (ASLD), Arizona Department of Administration Risk Management (ADOA RM), and ADEQ. The middle tailings pile and discharging adit are located on private land. After multiple years of communication with ADEQ, the private landowner ultimately decided not to take action and ADEQ initiated compliance and enforcement action against the private landowner. During the legal process, ADEQ was granted site access in 2018 and moved forward with funding remediation through the ADEQ Water Quality Assurance Revolving Fund (WQARF). The private landowner was convicted of three felony Clean Water Act violations and ordered to pay over $2.7 million in fines and over $2.3 million in restitution.

In 2019 ADEQ and Tetra Tech dewatered and plugged the adit using primary and secondary concrete hydrostatic plugs (Figure 4). All three tailings piles were graded to minimize erosion and to direct stormwater flow away from the piles. Water pumped from the adit was used for construction dust control. The tailings were then covered with geotextile and capped with waste rock and clean soil (Figure 5). A layer of native seeds was added to promote vegetation growth. Additional openings and shafts to the mine were closed for public safety. See ADEQ's YouTube project video for more details.

Results

Remediation of the Hillside Mine improved Boulder Creek. The iron-orange water is now clear and blue. Cattails and other vegetation are becoming re-established and fish have returned to the creek. Post-remediation data collected (using NPS funds) showed no exceedances of surface water quality standards in Boulder Creek during several sampling events (Table 1).

Table 1. Sampling Results on Boulder Creek, Before and After Remediation

Parameter	Pre-remediation (µg/L)	Post-remediation (µg/L)	% Improved
Zinc	557	53	90%
Copper	14	4	74%
Arsenic	175	139	21%

Partners and Funding

The project was a collaborative effort, with involvement from ADEQ, ASLD, ADOA RM, Arizona Attorney General's Office, BLM, EPA Region 9, Tetra Tech and subcontractors. The achievement was only possible with the wide-ranging support and expertise from the team. This project truly improved the water for the beneficial use of all plants, wildlife, insects, and people of Arizona. ADEQ provided over $3 million in funding for the project. Funding sources for the project included (1) lower tailings pile remediation: ASLD, ADOA RM and ADEQ CWA section 319; (2) upper tailings pile remediation: BLM; and (3) adit and middle tailings pile remediation: ADEQ WQARF.

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